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Cestoda from Lake Fishes in Wisconsin: Occurrence of *Proteocephalus* in *Esox* and Other Fish Species

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ABSTRACT: At least 4 species of *Proteocephalus* are reported from Silver and Tichigan lakes in southeastern Wisconsin: *P. pinguis* LaRue, 1911 and *P. percae* (Müller, 1780) from northern pike, *Esox lucius,* and *P. perplexus* LaRue, 1911 and *P. singularis* LaRue, 1911 from longnose gar, *Lepisosteus osseus. Proteocephalus singularis* was also recovered from a bluegill, *Lepomis macrochirus* (a new host record). One thousand eight hundred twelve fishes from 32 species from both lakes and 1,543 fishes from 27 species from connected waters were examined. Many larval forms of *Proteocephalus,* including *P. ambloplitis* (Leidy, 1887), are also reported from 10 species of fish. *Proteocephalus percae* appears to represent a new geographic record in North America. The most common species was *P. pinguis.* This tapeworm was considerably larger than previous descriptions indicate and was equally abundant in both lakes surveyed. It was more common in males than females and in older than younger *Esox.* Recruitment occurred in late summer and autumn, development in winter, and sexual maturity and reproduction in the spring. The infectious cycle in the definitive host was from August–September to April–May and in the intermediate host was during the summer. No seasonal migration was observed. For the most part, worms established, developed, matured, and reproduced in the anterior part of the small intestine. The helminth fauna of *E. lucius* in southeastern Wisconsin is considered poor compared to that of the same host in more northern latitudes. The only other helminth parasites recovered were *Leptorhynchoides thecatus* (rare), *Camallanus oxycephalus* (rare), and *Neoechinorhynchus cylindratus* (more common). This is the first report of the seasonal ecology of *P. pinguis* in North America.

KEY WORDS: Cestoda, Wisconsin fish, *Proteocephalus* spp., ecology, host distribution, seasonal distribution, host sex, host size, site selection.

This is the fourth in a series of reports on the ecology and seasonal relationships of cestode parasites of fish from 2 eutrophic lakes (1 river-fed and 1 land-locked) in southeastern Wisconsin. The first report on Caryophyllaeidae (Amin, 1986a) included the description of a new species, *Isoglaridacris multivitellaria.* The second (Amin, 1990) dealt with *Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900 in its fish intermediate hosts. The third (Amin and Cowen, 1990) elucidated the role of bowfin, *Amia calva,* largemouth bass, *Micropterus salmoides,* and smallmouth bass, *M. dolomieui,* in the cycling of *P. ambloplitis* suprapopulations in Wisconsin and the seasonal ecology of *Haplobothrium globuliforme* Cooper, 1914 in bowfin. This paper also included records of at least 3 other species of *Proteocephalus* accidentally infecting bass. The present work addresses all other species of *Proteocephalus* obtained from these 2 lake systems, with particular emphasis on the ecology of the most common species, *P. pinguis.*

Previous studies of fish parasites in various Wisconsin waters usually included parasite–host lists, which were occasionally annotated. Those studies that contained host records similar to those found in the present investigation include Pearse (1924), Bangham (1944), and Fischthal (1947, 1952). Additional data from pike were reported from elsewhere by Hunter (1929), Van Cleave and Mueller (1934), Watson and Dick (1980), and Muzzall (1984). Most recently, Shostak and Dick (1989) studied the position of *P. pinguis* within the intestine of naturally infected *E. lucius* relative to host stomach contents. The ecological information included herein is reported for *P. pinguis* in North America for the first time.

Materials and Methods

The fishes examined were from Silver Lake (Kenosha County), a 188-ha eutrophic land-locked lake, and from Tichigan Lake (Racine County), a 458-ha lake in an advanced state of eutrophication on the Fox River (a tributary of the Mississippi River). Seasonal collections were made from both lakes during the spring (April), summer (June, July, and early August), and autumn (late October and November) between 1977 and 1979 and from Silver Lake during the summer of 1976.

One thousand eight hundred twelve fishes representing 32 species and 10 families (Amiidae, 1 species; Catostomidae, 7; Centrarchidae, 9; Cyprinidae, 2; Esocidae, 2; Ictaluridae, 4; Lepisosteidae, 1; Percidae, 2; Salmonidae, 2; Serranidae, 2) were captured by electroshocking from lakes. An additional 1,543 fishes representing 27 species and 11 families (Amiidae, 1; Cato-

Table 1. Comparison between the major anatomical features of *Proteocephalus pinguis* from Wisconsin and those from the original description by LaRue (1914).

Character	Wisconsin material* $\bar{x}$ (range)	Original description
Strobila		
Length (mm)	206.93 (114–440)	Up to 90
Max. width (mm)	2.00 (1.20–2.60)	1.24
Scolex		
Length (mm)	2.28 (1.60–2.40)	0.20–0.25†
Max. width (mm)	0.91 (0.72–1.20)	0.35; up to 0.45
Sucker diameter (μm)	160 (133–210)	95–105
5th sucker diameter (μm)	103 (70–140)	50–75
Testis		
Dimensions (μm)	92 × 78 (42–140 × 42–112)	50 × 40–50
Number	60 (49–82)	54–70
Cirrus sac		
Length (μm)	261 (154–420)	130–140
Max. width (μm)	102 (70–140)	50–60
Egg dimensions (μm)	22 × 19 (19–26 × 16–26)	18 × 16

* $N = 15$; all mature adults, some gravid, obtained during the spring.
† Probably a misprint for 2.0–2.5 mm.

stomidae, 3; Centrarchidae, 6; Cyprinidae, 5; Cyprinodontidae, 2; Esocidae, 2; Gasterosteidae, 1; Ictaluridae, 4; Percidae, 3; Serranidae, 1; Umbridae, 1) were collected in a channel draining the swampy western area of Tichigan Lake, using seines or minnow traps.

Fish were systematically dissected shortly after capture. Parasites were systematically recovered from predesignated gut regions comprising the stomach (region A), small intestine (region B), and the first and second halves of the large intestine (regions C1 and C2). Cestodes were processed and mounted as in Amin (1986a) and placed in 3 categories: juveniles (strobila with only immature proglottids), adults (posterior proglottids sexually mature), and gravid (at least some proglottids with eggs). Mean values refer to the number of worms recovered/number of fish examined. Representative specimens were deposited in the U.S. National Museum Helminthological Collection (USNM Helm. Coll.) and in the University of Nebraska State Museum's Harold W. Manter Laboratory Collection (HWML Coll.). Slides of additional material are in the author's collection.

Results

Proteocephalus pinguis LaRue, 1911

Major anatomical structures of *P. pinguis* were measured and compared with those in the original description of LaRue (1914) (Table 1). All specimens studied were recovered from *E. lucius* in both Silver and Tichigan lakes proper during autumn, spring, or summer.

The prevalence and intensity of infection of *P. pinguis* in *E. lucius* were almost identical from the land-locked Silver Lake (75%, 10.8) and the river-fed Tichigan Lake (73%, 10.5) (Table 2). In addition, 1 55-cm-long northern pike obtained in February 1978 from Silver Lake yielded 9 worms (1 gravid and 8 mature), 2 other *E. lucius* obtained on 30 May 1979 in Tichigan Lake canal yielded 87 worms (17 gravid, 53 adults, and 17 juveniles), and 1 of 3 pickerel, *Esox americanus,* examined from Silver Lake yielded 1 juvenile *P. pinguis* in October 1978.

The prevalence and intensity of *P. pinguis* infections in *E. lucius* males and females of various sizes (total length) are shown in Table 3. Infections were more prevalent and heavier in males (87%, 12.8) than in females (58%, 8.1) and in larger than in smaller fish.

Both prevalence and intensity of *P. pinguis* in *E. lucius* from both lakes were lowest in the summer (43%, 1.9), increased in the autumn (68%, 8.5), and peaked in the spring (100%, 19.2) (Table 2). Gravid worms and juveniles were recovered during all seasons, but the largest proportion of juveniles (74%) and smallest proportion of gravid worms (3%) were observed in the autumn (Table 4). Most worms (96%) matured by April, and one-half of these were gravid. The few worms recovered in the summer were mostly juveniles (77%).

The largest concentration of worms in pike was

Table 2. Prevalence and intensity of *Proteocephalus pinguis* infections in *Esox lucius* from Silver and Tichigan lakes proper, 1977 and 1978.

Lake	Autumn (late Oct, Nov)	Spring (Apr)	Summer (Jun–early Aug)	Total
Silver				
Fish: inf./exam. (%)	10/15 (67)	5/5 (100)	0/0	15/20 (75)
Cestodes: no. ($\bar{x}$/fish) max.	128 (8.5) 37*	88 (17.6) 32	0*	216 (10.8) 37
Tichigan				
Fish: inf./exam. (%)	5/7 (71)	8/8 (100)	3/7 (43)	16/22 (73)
Cestodes: no. ($\bar{x}$/fish) max.	58 (8.3) 15	161 (20.1) 49	13 (1.9) 9	232 (10.5) 49
Total				
Fish: inf./exam. (%)	15/22 (68)	13/13 (100)	3/7 (43)	31/42 (74)
Cestodes: no. ($\bar{x}$/fish) max.	186 (8.5) 37	249 (19.2) 49	13 (1.9) 9	448 (10.7) 49

* One of 2 *Esox americanus* collected during the autumn was infected with 1 juvenile *P. pinguis*, and another *E. americanus* examined during the summer was not infected.

in the region of the small intestine directly behind the stomach during all seasons (Table 5). In the autumn, spring, and summer, 32%, 5%, and 8% of the worms, respectively, were distributed elsewhere.

Proteocephalus percae (Müller, 1780)

This was the only other species of *Proteocephalus* recovered from *E. lucius* in this study. Ten specimens were obtained: 7 worms (3 gravid and 4 mature) from 2 *E. lucius* in Silver Lake in November 1978, 2 (1 gravid and 1 juvenile) from 1 *E. lucius* in Tichigan Lake in July 1978, and 1 gravid worm from *E. americanus* in Tichigan Lake canal in June 1978.

Proteocephalus perplexus LaRue, 1911

Only 1 gravid worm of this species was recovered from the stomach of a 59-cm male longnose gar, *Lepisosteus osseus,* in Silver Lake on 25 June 1978. Fourteen and 9 gar were examined from Silver and Tichigan lakes, respectively.

Proteocephalus singularis LaRue, 1911

Four gravid worms were recovered from the stomach (1 extended considerably into gut region B directly behind the stomach) of a 89-cm female longnose gar in Silver Lake on 21 June 1978. An additional gravid worm was recovered from the intestine of a bluegill, *Lepomis macrochirus,* in Silver Lake on 1 May 1982; this is a new host record. Three hundred one and 212 bluegill were examined from Silver and Tichigan lakes, respectively.

Proteocephalus spp.

Plerocercoids of at least 2 other species of *Proteocephalus* were recovered from the intestine or body cavity of 10 fish species from 7 families from Tichigan Lake canal and Silver Lake (Table 6). As with *P. ambloplitis* (Amin, 1990), most of these were recovered from other hosts, with the definite exception of those from starhead topminnow, *Fundulus notti,* and blackstripe topminnow, *F. notatus* (see footnotes of Table 6).

Table 3. Prevalence and intensity of *Proteocephalus pinguis* infections based on sex and size of *Esox lucius* from Silver and Tichigan lakes.

Fish total length (cm)	Male fish	Female fish	Total
10–24	2/3 (67) 4.7*	0/2	2/5 (40) 2.8
25–39	2/3 (67) 2.0	1/1 (100) 1.0	3/4 (75) 1.8
40–54	12/13 (92) 15.7	2/4 (50) 9.7	14/17 (82) 14.3
55–69	2/2 (100) 15.5	6/9 (67) 11.9	8/11 (73) 12.5
≥70	2/2 (100) 19.5	2/3 (67) 2.3	4/5 (80) 9.2
Total	20/23 (87) 12.8	11/19 (58) 8.1	31/42 (74) 10.7

* No. of fish infected/no. of fish examined (% prevalence) $\bar{x}$ intensity.

Table 4. Seasonal development of *Proteocephalus pinguis* in *Esox lucius* from Silver and Tichigan lakes (combined), 1977 and 1978.

Cestode developmental stages	Total no. of worms	No. and prevalence (%) of worms		
		Autumn (late Oct, Nov)	Spring* (Apr)	Summer (Jun–early Aug)
All stages	448	186	249	13
Juvenile (%)†	158	138 (74)	10 (4)	10 (77)
Mature (%)	163	43 (23)	119 (48)	1 (8)
Gravid (%)	127	5 (3)	120 (48)	2 (15)

* One *E. lucius* from Tichigan Lake canal collected on 30 May 1979 yielded 87 worms (17 juveniles, 53 mature, and 17 gravid adults).

† The percent prevalence compares data in vertical columns.

Discussion

The classical features of spatulate scolex, sucker interrelationships, and reproductive details characteristic of *P. pinguis* were clearly evident in the Wisconsin specimens, which were, however, considerably larger than those in the original description. The strobilae of some of the Wisconsin specimens were about 5 times as long as the maximum of 90 mm reported by LaRue (1914) and Hunter (1929). Meyer's (1958) specimens from Iowa did not "exceed the limits prescribed for this species except in the dimension of the cirrus pouch." Size differences in the structures compared in Table 1 suggest that ratios among measurements of certain structures, e.g., suckers or suckers and scolex, may be more important than raw measurements for species diagnosis. Differences in the dimensions of such critical diagnostic characteristics as suckers, testes, cirrus sac, and eggs are particularly noteworthy.

The recovery of *P. pinguis* solely from *Esox*, although 32 species of fish (N = 1,812) were examined from Silver and Tichigan lakes and 27 species (N = 1,543) from Tichigan Lake canal, agrees with the previously published literature indicating the high host specificity of this widely distributed cestode.

In *Esox*, infections with *P. pinguis* may be quite heavy because 2 links in the food chain, crustaceans and fish as intermediate hosts (first noted by Hunter, 1929), serve to infect younger and older pike, respectively. Van Cleave and Mueller (1934), Watson and Dick (1980), and Muzzall (1984) reported prevalences of 100%, 96.2%, and 92%, respectively, with an average intensity of 70 worms per fish reported by Watson and Dick (1980) and up to 100 worms per fish reported by Van Cleave and Mueller (1934). These values do not vary much from those obtained in the present study (Table 2).

The main variation, however, appears to result from latitudinal differences in the complexity of the helminth fauna of *E. lucius*. The parasite fauna of *E. lucius* is considerably richer in diversity in more northern waters. For example, Fischthal (1953) and Watson and Dick (1980) found 21 and 18 helminth species in *E. lucius* from northern Wisconsin and Manitoba, respectively. Of the 5 species in the family, the holarctic *E. lucius* has the greatest tolerance to cold environments and is the only species to extend into the arctic (Lee et al., 1980). Southern Wisconsin is near the southern edge of the natural range of *E. lucius*. Fish closer to the center of their range appear to harbor richer parasitic faunas than those of marginal distribution. In addition to *P. pinguis* (and *P. percae*), only the acanthocephalans *Leptorhynchoides thecatus* (Linton, 1891) Kostylev, 1924 (3 juveniles from 2/20 fish in Silver Lake [Amin, 1988]) and *Neoechinorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1919 (590 worms from 9/20 fish in Silver Lake [Amin, 1986b]) and the nematode *Camallanus oxycephalus* Ward and Magath, 1916 (4 worms from

Table 5. Seasonal site selection of *Proteocephalus pinguis* in *Esox lucius* from Silver and Tichigan lakes proper (combined), 1977 and 1978.

Season	No. of worms	% worms in intestinal regions (juvenile, adult, gravid)*			
		A	B	C1	C2
Autumn	186	9 (100, 0, 0)	68 (67, 33, 0)	11 (86, 14, 0)	12 (100, 0, 0)
Spring	249	0	95 (4, 49, 47)	4 (0, 25, 75)	1 (0, 50, 50)
Summer	13	0	92 (75, 8, 17)	0	8 (100, 0, 0)

* Juvenile = worms with only immature segments, adult = worms with sexually mature segments, gravid = adult worms with segments containing eggs. A, stomach; B, small intestine; C1 and C2, first and second halves of large intestine.

Table 6. Plerocercoids of *Proteocephalus* recovered from various Tichigan Lake canal (TLC) and Silver Lake (SL) fishes, 1977-1979.

Fish species	Location	No. of fish infected/no. examined (no. of worms) Autumn (late Oct, Nov)	Spring (Apr)	Summer (Jun–early Aug)	Site of infection	Remarks
Centrarchidae						
*Lepomis macrochirus**	TLC	0/0	0/57	3/64 (4)	Gut lumen	Minute larvae
	SL	0/141	3/62 (4)	3/98 (3)	Gut lumen	Large (up to 35 mm) larvae
*Pomoxis nigromaculatus**	SL	0/18	3/25 (6)	0/4	Gut lumen	Minute and small larvae
Cyprinodontidae						
Fundulus notatus†	TLC	0/0	1/1 (10)	6/18 (22)	Gut lumen	Long (up to 20 mm), slender
Fundulus notti†	TLC	0/0	0/0	4/6 (70)	Gut lumen	Larvae–juveniles (some segmented)
Gasterosteidae						
Culaea inconstans	TLC	0/2	0/45	4/135 (4)	Gut lumen	Minute larvae, in 3 hosts
					Gut wall	Cysts, in 1 host
Ictaluridae						
Ictalurus melas	SL	0/0	0/0	1/1 (1)	Gut lumen	20-mm larva
Lepisosteidae						
*Lepisosteus osseus**	SL	0/0	0/3	1/11 (12)	Gut lumen	ca. 10-mm larvae
Percidae						
Etheostoma nigrum	TLC	0/1	2/108 (many)	0/14	Gut wall	Minute cysts
*Perca flavescens**	TLC	0/0	0/0	1/2 (3)	Gut lumen	Minute larvae
Umbridae						
Umbra limi	TLC	1/10 (4)	2/66 (70)	0/10	Body cavity	Mostly minute cysts

* Parenteric plerocercoids of *Proteocephalus ambloplitis* have been reported from these fish intermediate hosts in Tichigan and Silver lakes proper (Amin, 1990).
† Worms from these fish are definitely not *Proteocephalus ambloplitis.*

3/22 fish in Tichigan Lake [Amin, 1984]) were reported in southeastern Wisconsin.

The almost identical infection parameters of *P. pinguis* in *E. lucius* from the land-locked Silver Lake and the larger, more eutrophic, and river-fed Tichigan Lake (Table 2) suggest that these environmental factors do not significantly affect infection of northern pike with this cestode. In all other helminth species examined, some were either more dominant in Silver Lake, e.g., *P. ambloplitis* (Amin, 1990; Amin and Cowen, 1990), caryophyllaeid cestodes (Amin, 1986a), and *Neoechinorhynchus* spp. (Amin, 1986b), or in Tichigan Lake, e.g., *Pomphorhynchus bulbocolli* Linkins *in* Van Cleave, 1919 (Amin, 1987).

The relatively higher values of prevalence and mean intensity of *P. pinguis* infections in larger fish (Table 3) probably reflect the greater volume of food, including infected fish as intermediate hosts, consumed by these pike (Lawler, 1965; Kipling and Frost, 1970). Cannibalism, as suggested by Hunt and Carbine (1951) in Michigan and Lawler (1965) in Canada, may also contribute an additional source of infection of larger pike. However, the abundance of *P. pinguis* in Manitoba was found to be independent of *E. lucius* age or sex (Watson and Dick, 1980); no data were supplied. This was attributed to "constant intake of *P. pinguis* during the transition of diet from copepods to small fish. . . ." The sizes of Watson and Dick's (1980) fish were not indicated, and the relevance of their interpretation to the data presented here remains questionable because most of the Wisconsin pike reported have already passed that "transitional" stage.

Data in Tables 2 and 4 indicate that recruitment of *P. pinguis* begins in the summer, when pike are scarcely infected. Major recruitment, however, occurs in the autumn, when worm numbers show significant build-up. Maturation, reproductive activity, and abundance reach a peak in the spring (April) before worms are subsequently lost. The few juvenile and gravid worms obtained during the summer (Table 4) are new recruits and late evacuees, respectively. The generation cycle of *P. pinguis* thus appears to take <1 yr in *E. lucius,* with the immature stages developing in the crustacean intermediate hosts mostly during the summer. *Esox* acquire *P. pinguis* infections by feeding on infected crustacean or fish intermediate hosts. Watson and Dick (1980) also reported highest abundance of *P. pinguis* in *E. lucius* during "late winter" (the Manitoba winter extends January–April). They provided no numerical data but mentioned the "loss of gravid worms during spring" (May–June). Hunter (1929) also recovered an adult *P. pinguis* from a pike on 15 August in New York and indicated that "the parasite may reach maturity in one year."

Related species of *Proteocephalus* showing a similar seasonal abundance pattern include *P. pearsei* LaRue, 1914 from yellow perch (*Perca flavescens*) in Ontario (Cannon, 1973), *P. exiguus* LaRue, 1911 from lake whitefish (*Coregonus clupeaformis*) and cisco (*C. artedii*) in Manitoba (Watson and Dick, 1979) and from grayling (*Thymallus arcticus*; in which the tapeworm does not mature) in Lake Baikal, U.S.S.R. (Rusinek, 1987a, b), and *P. filicollis* Rudolphi, 1802 from *C. artedii* in Manitoba (Watson and Dick, 1979). Only Watson and Dick (1979) referred to the May loss of gravid adults and their replacement by immatures in June. Similar seasonal patterns were better documented for *P. filicollis* from threespine stickleback (*Gasterosteus aculeatus*) in England (Hopkins, 1959), *P. torulosus* (Batsch, 1786) from dace (*Leuciscus leuciscus*) in England (Kennedy and Hine, 1969), and *P. percae* from *E. lucius* in Czechoslovakia (Moravec, 1979).

The gut region directly behind the stomach of *E. lucius* appears to be the site in which *P. pinguis* undergoes establishment, development, maturation, and sexual reproduction. Most mature and gravid worms as well as juvenile worms were localized in this gut region during the spring and autumn, respectively. The autumn juveniles found in the stomach or large intestine (Table 5) may have been either incoming or evacuating after unsuccessful establishment. *Proteocephalus pinguis* thus does not appear to undertake seasonal migration in the intestinal tract of *E. lucius.* Shostak and Dick (1989) observed that *P. pinguis* did not migrate in the intestine of *E. lucius* from Manitoba in response to feeding activity of the host.

Proteocephalus percae is normally reported from *Perca* and *Esox,* among other fishes, in Europe (LaRue, 1914; Yamaguti, 1959). I am not aware of any other record of *P. percae* in North America. The anatomical similarities to LaRue's (1914) description of the species were compelling even though some measurements did not quite match.

Proteocephalus perplexus appears to be a com-

mon cestode of *Amia calva* and *Lepisosteus*; *P. singularis* is common in *Lepisosteus* in Wisconsin and elsewhere in North America (Pearse, 1924; Bangham, 1944; Fischthal, 1947, 1952; Hoffman, 1967). The record of *P. singularis* from *Lepomis macrochirus* is new but not considered accidental because the worm was gravid. Like *P. pinguis,* measurements of *P. singularis* were considerably larger than those included in LaRue's (1914) description.

Pomoxis nigromaculatus, Lepomis macrochirus, Ictalurus melas, Perca flavescens, and *Lepisosteus osseus,* from which plerocercoids resembling those of *P. ambloplitis* were recovered (Table 6), are intermediate hosts of *P. ambloplitis* in the same waters (Amin, 1990). *Umbra limi* also had plerocercoids of *Haplobothrium globuliforme* Cooper, 1914, which, like *P. ambloplitis,* utilizes *A. calva* as a definitive host (Amin and Cowen, 1990). The plerocercoids from *Etheostoma nigrum* and *Culaea inconstans* were similar to those from *U. limi*; all 3 host species are common forage fish for *A. calva* (Amin, unpubl.). This suggests that the plerocercoids from *U. limi, E. nigrum,* and *C. inconstans* may be *P. ambloplitis.* Plerocercoids from *Fundulus notti* and *F. notatus* were clearly different.

Deposited Specimens

Proteocephalus pinguis from *E. lucius*: Silver L., HWML Coll. Nos. 31136–31140; Tichigan L., USNM Helm. Coll. Nos. 80847–80850. *Proteocephalus* sp. from *U. limi* (Tichigan L.): HWML Coll. No. 31141 and USNM Helm. Coll. No. 80851; from *F. notti* (Tichigan L.): HWML Coll. Nos. 31142, 31147; from *F. notatus* (Tichigan L.): USNM Helm. Coll. No. 80852; from *C. inconstans* (Tichigan L.): HWML Coll. No. 31144 and USNM Helm. Coll. No. 80853; from *L. macrochirus*: Silver L., HWML Coll. Nos. 31144, 31148; Tichigan L., USNM Helm. Coll. No. 80854. *Proteocephalus percae* from *E. lucius* (Silver L.): HWML Coll. No. 31145 and USNM Helm. Coll. No. 80855. *Proteocephalus singularis* from *L. osseus* (Silver L.): HWML Coll. Nos. 31146, 31149 and USNM Helm. Coll. No. 80856. Slides of other material are in the author's collection.

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